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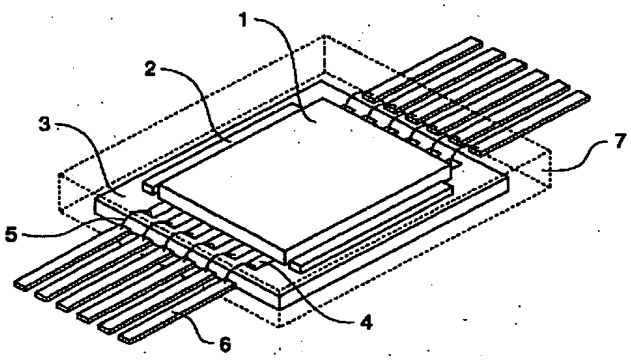
(54)【発明の名称】光配線装置

(57)【要約】
【課題】電気配線装置と同等の実装性をもち、光配線の特徴を効果的に発揮できる光配線パッケージ及び光配線装置を提供する。
【解決手段】パッケージ基板により光電変換素子と光端子の光軸を合せ、光端子先端を光配線基板凹部との勘合部とする。また、光端子のレンズ焦点を光配線基板内に置くことで光導波路を表面に露出させないようにする。



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【特許請求の範囲】

【請求項１】基板と、この基板上に配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子とを具備し、前記集積回路への入力は、前記光端子を介して前記光電変換素子へ光信号を入力し、前記光電変換素子が前記光信号を電気信号に変換し、この電気信号を前記集積回路に入力することによって行われることを特徴とする光配線装置。

【請求項２】基板と、この基板上に配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子とを具備し、前記集積回路からの出力は、前記集積回路から電気信号を前記光電変換素子へ出力し、この電気信号により前記光電変換素子が光信号に変換し、この光信号を前記光端子を介して出力することによって行われることを特徴とする光配線装置。

【請求項３】前記基板に設けられた貫通孔は傾斜側面を有し、この傾斜側面によって前記光端子が位置決めされることを特徴とする請求項１或いは請求項２記載の光配線装置。

【請求項４】パッケージ基板と、このパッケージ基板上に対向配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記パッケージ基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子と、前記光端子を介し前記パッケージ基板と対向配置された光配線基板とを具備し、前記集積回路への入力は、前記光端子を介して前記光電変換素子へ光信号を入力し、前記光電変換素子が前記光信号を電気信号に変換し、この電気信号を前記集積回路に入力することによって行われることを特徴とする光配線装置。

【請求項５】パッケージ基板と、このパッケージ基板上に対向配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記パッケージ基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子と、前記光端子を介し前記パッケージ基板と対向配置された光配線基板とを具備し、前記集積回路からの出力は、前記集積回路から電気信号を前記光電変換素子へ出力し、この電気信号により前記光電変換素子が光信号に変換し、この光信号を前記光端子を介して出力することによって行われることを特徴とする光配線装置。

【請求項６】前記パッケージ基板に設けられた貫通孔は傾斜側面を有し、前記光配線基板の前記光結合された部

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分は傾斜側面を持った凹部が設けられ、これらの傾斜側面によって前記光端子、前記光導波路、前記光電変換素子が光結合するように位置決めされることを特徴とする請求項４或いは請求項５記載の光配線装置。

【請求項７】前記光端子による光結像位置を前記凹部底面より深い位置とし、この位置に前記光導波路を位置させることによって、前記光導波路を前記光配線基板の表面に露出させないことを特徴とする請求項４或いは請求項５光配線装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、集積回路を高速実装するための光配線装置に関する。

【０００２】

【従来の技術】バイポーラトランジスタや電界効果トランジスタ等の電子デバイスの性能向上により、ＬＳＩは飛躍的な高速動作が可能になってきている。しかしながら、ＬＳＩの内部動作は高速化されているものの、ＬＳＩチップを実装したプリント基板レベルやこのプリント基板を装着したラックでの動作速度はＬＳＩの動作速度より低く抑えられている。この理由は、プリント基板やラックでは、動作周波数を上昇させると電気配線の伝送損失や雑音、電磁障害が増大するため、特に信号を劣化させないために長い配線ほど動作周波数を下げる必要がでてくるためである。従って、電気配線装置では、能動素子であるＬＳＩの動作速度を向上させても、プリント基板やラックにおける問題のために動作速度を向上できないという問題がある。一方、上述のような電気配線装置の問題を鑑み、ＬＳＩ間を光で接続する光配線装置がいくつか提案されている。光による配線の特徴は、直流から数十ＧＨｚ以上の周波数領域で損失等の周波数依存性が殆ど無く、また、配線経路の電磁障害や接地電位変動雑音が無いため数十Ｇｂｐｓの配線が可能である。この光配線装置を実現するためには光導波路を用いた配線が必要となる。一般に光導波路の接続は平板光導波路基板の突き合わせや光ファイバの突き合わせで行われ、電気の配線方法に比し汎用性が少ない。このため、光配線装置は電気配線装置に比し一般的ではなく、極限られた特殊装置でのみ用いられている。

【０００３】

【発明が解決しようとする課題】本発明は、上記問題点を解決し、ＬＳＩを汎用的に光配線実装するための光配線線装置を提供することを目的とする。

【０００４】

【課題を解決するための手段】上記目的を達成するために、本発明は、基板と、この基板上に配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子とを具備し、前記

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集積回路への入力は、前記光端子を介して前記光電変換素子へ光信号を入力し、前記光電変換素子が前記光信号を電気信号に変換し、この電気信号を前記集積回路に入力することによって行われることを特徴とする光配線装置を提供する。また、本発明は、基板と、この基板上に配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子とを具備し、前記集積回路からの出力は、前記集積回路から電気信号を前記光電変換素子へ出力し、この電気信号により前記光電変換素子が光信号に変換し、この光信号を前記光端子を介して出力することによって行われることを特徴とする光配線装置を提供する。

【０００５】また、前記基板に設けられた貫通孔は傾斜側面を有し、この傾斜側面によって前記光端子が位置決めされることを特徴とする光配線装置を提供する。また、パッケージ基板と、このパッケージ基板上に対向配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記パッケージ基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子と、前記光端子を介し前記パッケージ基板と対向配置された光配線基板とを具備し、前記集積回路への入力は、前記光端子を介して前記光電変換素子へ光信号を入力し、前記光電変換素子が前記光信号を電気信号に変換し、この電気信号を前記集積回路に入力することによって行われることを特徴とする光配線装置を提供する。また、パッケージ基板と、このパッケージ基板上に対向配置された集積回路と、前記基板上に設けられ、前記集積回路と電気信号のやり取りをする光電変換素子と、前記パッケージ基板の一部に設けられた貫通孔と、この貫通孔に配置され、前記光電変換素子と対向する曲面を有する光端子と、前記光端子を介し前記パッケージ基板と対向配置された光配線基板とを具備し、前記集積回路からの出力は、前記集積回路から電気信号を前記光電変換素子へ出力し、この電気信号により前記光電変換素子が光信号に変換し、この光信号を前記光端子を介して出力することによって行われることを特徴とする光配線装置を提供する。

【０００６】また、前記パッケージ基板に設けられた貫通孔は傾斜側面を有し、前記光配線基板の前記光結合された部分は傾斜側面を持った凹部が設けられ、これらの傾斜側面によって前記光端子、前記光導波路、前記光電変換素子が光結合するように位置決めされることを特徴とする光配線装置を提供する。また、前記光端子による光結像位置を前記凹部底面より深い位置とし、この位置に前記光導波路を位置させることによって、前記光導波路を前記光配線基板の表面に露出させないことを特徴とする光配線装置を提供する。本発明の骨子は、集積回路

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（ＬＳＩ）パッケージ内部にＬＳＩ及び光半導体素子を搭載するパッケージ基板を設け、そのパッケージ基板に設けられた貫通孔により、光半導体素子と先端が半球又は先端が球テーパ形状の光入出力端子の光軸のアライメントを行うことである。また、光配線基板の光入出力部に凹部を設け、前記光入出力端子を機械的に固定すると共にパッケージ基板と光配線基板を位置合わせし、光入出力端子のレンズの焦点を光配線基板内部にある光導波路におくものである。また、集積回路の電源および低速信号端子は電気接続ピンを通して電気的に接続し、高速信号は光電変換素子、光端子、光導波路を通して行うものである。このようにして集積回路内の電子素子に電源を与え、かつ高速信号は光信号によって行えるので、ボードレベルでの信号の劣化を防ぐことができる。

【０００７】本発明によれば、光電変換素子と光導波路の光軸調整を、光電変換素子と光入出力端子との調整、光入出力端子と光導波路との調整、に分離するため、ＬＳＩパッケージ、配線基板実装といった通常のＬＳＩ実装と同様な工程分離が可能である。従って、ＬＳＩパッケージと配線基板の作製が独立に行え、光配線基板の作製に光電変換素子の実装がないため光配線基板の大型化が容易となる。また、ＬＳＩパッケージは、予め光端子を設けたパッケージ基板を用いることで光電変換素子搭載といった最小限の工程追加で通常のＬＳＩパッケージ工程に投入できる。更に、光配線基板実装においては電気端子の位置合わせ程度の精度で光端子を機械的に勘合させることが可能であり、個別の光軸合わせが不要なため他の電子素子等と同時の実装が可能となる。また、光端子の焦点位置を光配線基板の内部に位置させるため、光配線基板の表面汚染の制限が緩和され、その取扱いが容易となる。このように本発明の光配線パッケージ及び光配線装置に依れば、光配線固有の工程が最小限に抑えられ、一般的な電子素子実装の手法が適用可能となるため、実装コストを大幅に上昇させることなく光配線実装が可能となり、ボードレベル、ラックレベルで高速動作可能なシステムを安価に構築できるという効果を奏する。

【０００８】

【発明の実施の形態】以下、図面を参照しながら本発明の詳細を説明する。図１は、本発明の光配線パッケージの斜視図である。パッケージ基板３上に、ＬＳＩチップ１が、フリップチップ実装されている。ＬＳＩチップ１の脇には光電変換素子アレイ２が形成され、ＬＳＩチップとは電気的に信号のやり取りを行う。パッケージ基板３上には電気内部配線４が形成され、電気端子６とワイヤーボンディング５で接続されている。これら電気的配線はＬＳＩの電源や低速信号と接続されている。ＬＳＩチップ１、光電変換素子アレイ２、内部配線４、パッケージ基板３ワイヤーボンディング５と電気端子６の一部は、モールド樹脂７によってモールドされパッケージ化

されている。光電変換素子アレイ２と光端子は、パッケージ基板３に形成された貫通孔を介して光結合されているが、具体的構成については後述する。このような光配線装置出は、ＬＳＩチップ１の電源配線及び動作モード制御信号等の低速信号は内部配線４及びボンディングワイヤ５を通じて電気端子６に接続される。一方、クロック信号やデータ等の高速信号は同様な内部配線または５と同様なボンディングワイヤにより光電変換素子アレイ２に接続され、光信号としてパッケージ基板３外部に接続される。

【０００９】このパッケージ基板３の作製工程の例としては、まず、光端子及び内部配線を形成したパッケージ基板３にＬＳＩチップ１と光電変換素子アレイ２を搭載する。このとき、ＬＳＩチップ１及び光電変換素子２をフリップチップ実装すれば、ＬＳＩチップ１とパッケージ基板３の内部配線４や光電変換素子アレイ２との電気接続は同時に行われる。または、それぞれワイヤボンディング５で接続しても構わない。また、光端子の形成と、ＬＳＩチップ１や光電変換素子アレイ２の搭載が逆の順序であっても構わない。次に、リードフレーム６へのワイヤ接続（ボンディングワイヤ５の形成）を行い、全体をエポキシ樹脂等の樹脂によりモールドし、リード（電気端子６）の切断と整形を行ってパッケージが完成する。このとき、後述するように光端子の先端はモールド樹脂の外部に露出するよう、金型を加工しておく。図２は、図１で示した本発明の光配線装置の構成例を示す断面図である。パッケージ基板３の傾斜側面を有する貫通孔が形成された部分には、光電変換素子アレイ２の光電変換素子能動部２００が対向するように配置され、キャップ部をフリップチップ実装用の半田ボールで形成している。

【００１０】この貫通後部には傾斜側面に収まるように球状レンズ（光端子）８が形成されている。貫通孔内部および光電変換素子アレイ２とパッケージ基板３とのギャップ部には透明樹脂９が充填されている。７は前記モールド樹脂である。この光配線装置は、パッケージ基板３の表面に光電変換素子２搭載用の配線及び半田ボール１０が形成されており、光電変換素子アレイ２を載せた後、熱処理により半田溶融を行うことで半田ボール１０が形成される。このとき、半田ボール１０の表面張力により光電変換素子アレイ２が所定位置に移動するため、初期の光電変換素子アレイ２の搭載は例えば±１０μｍといった比較的低精度の位置合わせでも良く、半田張力による所謂フリップチップボンディングによって最終的に１μｍ以下の精度が実現される。また、パッケージ基板３は、例えば異方性エッチングにより高精度に形成した貫通口を有するＳｉ基板を用いてもよい。ここに球レンズ８を勘合させ、前述のフリップチップボンディングと合わせることで、光電変換素子アレイ２と球レンズ８の光軸を機械的に高精度に合わせることができる。球レンズ８は透明樹脂９で仮固定しておき、パッケージのモールド樹脂７により最終的な固定を行う。

【００１１】作製工程としては、まず、パッケージ基板３に光電変換素子アレイ２の搭載を行い、例えば半田ボール１０をＡｕＳｎ共晶として不活性ガス雰囲気中で３００℃の熱処理を行う。次に、パッケージ基板３の貫通口に透明樹脂９として、例えば光電変換素子アレイ２にかかる応力を考慮して、シリコーン系樹脂を注入し、続いて球レンズ８を装着する。次に、この透明樹脂９を熱処理により硬化させた後、全体を樹脂モールドする。このとき、予め光電変換素子アレイ２と球レンズの間には透明樹脂９が充填されているためモールド樹脂７が光路に進入することはなく、モールド樹脂７の光学特性は特段考慮する必要がなく、逆に外界からの光の侵入を防ぐ意味からも光吸収特性の高い樹脂にしてもよい。また、モールド樹脂は通常のＬＳＩのパッケージ樹脂を用いることができ、例えば、ガラスフィラーを添加して熱膨張率調整したエポキシ樹脂等を用いれば良い。勿論、モールドする際の金型をモールド樹脂が光端子８の先端に被らないよう設定しておく。図３は、本発明の光配線装置を示す断面図であり、図２で示した光配線装置を光配線基板上に搭載したものである。図３に示すように、１１は光配線基板、１２は光導波路、１３は光結合のための光端子勘合部（凹部）、１４は透明樹脂であり、１４の透明樹脂は光配線パッケージの仮固定と光経路の保護材を兼ねている。

【００１２】光配線基板１１は、石英、多成分ガラス等の所謂ガラス系光導波路基板や、ポリメチルメタクリレート（ＰＭＭＡ）、弗化ポリイミド、ポリカーボネート（ＰＣ）等の所謂樹脂系光導波路基板を用いることができる。この実施例では、光導波路が水平方向に光伝播する形態のものであり、光導波路端部（光入出力部、基板凹部）において光路直交変換の４５° 加工が施されている。これは、回折格子による結合や内部ミラーによるもの等でも構わず、また、基板垂直方向に光伝播する形態の場合には、特に直交変換等の構成は不要である。この実施例の実装工程例としては、まず、光配線基板１１の光入出力部１３に透明樹脂又は透明樹脂接着剤１４を塗布し、光配線パッケージの搭載と透明樹脂１４による固定を行う。透明樹脂１４は、例えばシリコーン樹脂やエポキシ樹脂等の透明樹脂を用いれば良い。但し、一般の透明樹脂だけでは充填剤にはなるものの、後の工程で位置ずれを起こすため空スペースに接着剤を併用しても良い。また、アクリル系やエポキシ系の透明接着剤を用いれば光配線パッケージの固定も同時に行え、この時、紫外線硬化樹脂等を用いれば短時間に固定することができる。この工程は、一般のＬＳＩパッケージの実装で用いられる位置決めと接着剤による仮固定の工程に相当し、必ずしも光配線装置固有の付加工程ではない。

【００１３】次に、他のパッケージや電子素子等も仮固

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定し、光配線基板１１を半田リフロー工程にかけ、電気端子の半田接続を行う。この工程は、一般的ＬＳＩ実装と同様である。このように、本発明実施例の光配線装置では、一般のＬＳＩ実装とほぼ同等の工程で実装でき、光入出力端子部分に充填する樹脂材料の変更だけで通常の実装方法が適用できる。また、光導波路１２が光配線基板１１の表面に露出していないため、配線基板の洗浄工程なども通常のＬＳＩ実装基板と同様の工程で扱うことができ、洗浄液残差が多少あっても、光の焦点が基板内部にあるためその影響は小さい。これはコンパクトディスク等の光ディスクがレコード等に比し取り扱い易くなっている効果と同様の効果である。図４は、本発明の光配線パッケージの他の例である。この実施例の特徴は、図２の１０（半田バンプ）の代りに通常の接続半田１０’を用いることと、光電変換素子能動部２００をパッケージ基板３の貫通口に挿入し、その外形部を機械的に貫通口に当てて位置合わせすることである。この例の利点は、半田バンプ形成のためのパッシベーション膜や数十μｍといった厚い半田の形成が不要となることであり、また、半田バンプのためのリフロー工程が不要となるため、材料費、加工費の低減と工程時間の短縮が可能なことである。

【００１４】図２、図３の実施例にもちいる光半導体素子の例を図５、図６に示す。図５は発光電変換素子（アレイ）、図６は受光電変換素子（アレイ）であり、図５には発光電変換素子の例として垂直ＤＢＲ（Ｄｉｓｔｉｂｕｔｅｄ　Ｂｒａｇｇ　Ｒｅｆｒｅｃｔｏｒ）型半導体レーザ、図６には受光電変換素子の例としてｐｉｎ型フォトダオード（ＰＩＮ－ＰＤ）を示している。図５の２０１は半導体基板、２０２は下部積層ミラー、２０３は活性層、２０４は上部積層ミラー、２０５はモード制御部、２０６は表面パッシベーション、２０７は配線電極（上部用）である。発振波長の例として０．７８μｍ帯の場合、半導体基板２０１がＧａＡｓ、積層ミラー２０２、２０４がＡｌＡｓとＡｌＧａＡｓのλ／４膜、活性層２０３がＧａＡｌＡｓが所謂量子井戸としての薄膜ＧａＡｓ、表面パッシベーション膜２０６はＳｉＯ２膜やＳｉＮｘ膜等の誘電膜等を用いれば良い。モード制御部２０５は例えばＧａＡｓを埋め込み成長し、高次横モードや不要輻射光を除外する。この効果は、光端子の出力光に高角度の迷光が混入しないようにすることであり、光配線基板の本来の光入出力部以外に入る光を抑制し、クロストーク等の弊害を生じさせないようにするためのものである。

【００１５】図６の２０１は半導体基板、２０８は光吸収層、２０９は上部ウィンドウ層、２１０は不純物拡散領域である。上述の図５の例に合わせて、０．７８μｍ帯の受光の場合、２０１が高キャリア濃度のＧａＡｓ、２０８が低キャリア濃度のＧａＡｓ、２０９が高キャリア濃度のＡｌＧａＡｓとし、２１０には半導体基板２０１と逆の導伝型の不純物を熱拡散等で導入する。この素子にｐｎ逆バイアスを印可すると、２０８の低キャリア濃度層が空乏化して光吸収によるキャリアのドリフトを生じる。この結果、高速の応答が可能になり、数ＧＨｚ以上の高速応答が可能になる。尚、受光波長が０．７８μｍ帯の場合、Ｓｉを用いることができ、同様のキャリア濃度構造で全てＳｉを材料とすれば同等の機能が得られる。図５、図６の発光電変換素子、受光電変換素子は図に示すように能動部をメサ化加工し、配線電極２０７によりメサ下部に電極を延長している。これにより、図４のような機械的位置合わせの光配線パッケージにも適用できるようになる。この様子を図７に斜視図で示す。図７の２１１は接地電極であり、素子能動部２０４の配線電極２０７とはずれた位置に形成している。

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【００１６】図１乃至図６においては接地電極について特に触れていなかったが、これは基板２０１の下面から一括して配線しても良いが、図７のように個別に設け、パッケージ基板３上で配線電極２０７と同時に接続することもできる。その際、パッケージ配線が２０７から光電変換素子のアレイ配列方向と垂直の方向に引き出されるため、接地電極２１１はその空間を避けて設けている。これにより、接地電極と信号電極間の浮遊容量を低減することが可能である。尚、図５乃至図７の実施例で、発光電変換素子は発光ダイオードでも良く、受光電変換素子は金属半導体接触型素子でも良い。また、発光波長等は用いる光配線装置の設計や用いる材料等により変更可能であり、適宜変更、変形が可能である。図８は本発明の光配線パッケージの他の実施例であり、図２、図４で示した実施例の光配線端子の変形例である。この実施例の特徴は、光端子１５がガラスや樹脂の透明ロッドからなり、パッケージ基板３に集積素子や光電変換素子１５を搭載する以前に光端子を形成しておけるということにある。このため、図８の実施例では、パッケージ工程が集積素子及び光電変換素子の搭載、透明樹脂９の充填の後、即座に樹脂モールド工程に移る。従って、光端子数に応じたレンズの装着工程が無く、一般のＬＳＩパッケージとほぼ同等の工程が適用でき、光配線パッケージの工程が大幅に簡略化できる。

【００１７】図８の例では先球テーパーの光端子ロッドを用いているが、これは先端が半球の物でも良い。先球テーパーと半球の使い分けは、光学的な結合の設計や、光配線基板との勘合設計により使い分ければ良いものである。図９は、図８の実施例に用いる光電変換素子の例であり、図７と異なる点は配線電極２０７が素子表面側にあり、そのため接地電極２１１もダミーのメサ上に形成して表面側に形成している点である。この場合、ダミーメサのスペースが必要なため、配線電極２０７の引き出し電極が接地電極２１１の基板面部分で交差するが、メサの高さ分だけ空間的に離れているため、比較的浮遊容量も小さくできる。尚、図８の実施例においても、図

７の光電変換素子を用いることができる。また図２、図４の実施例に図９の光電変換素子を用いることができる。これらはパッケージ基板３及び光電変換素子の形状の変更で対応可能である。また上記実施例では、光電変換素子アレイ２と半導体集積回路を別に実装し電気的配線にて接続したが、半導体光電変換素子を半導体集積回路に集積化して用いてもよい。

【００１８】

【発明の効果】以上述べたように、本発明によれば一般的な電子素子の実装手法により光配線が可能となり、実装コストを大幅に上昇させることなく、ボードレベル、ラックレベルで高速動作可能なシステムを安価に構築できるという効果を奏する。

【図面の簡単な説明】

【図１】　本発明実施例の光配線パッケージの概略構成図

【図２】　本発明実施例の光配線パッケージの光端子部分を示す構成図

【図３】　本発明実施例の光配線装置の実装状態を示す構成図

【図４】　本発明実施例の光配線パッケージの光端子部分を示す構成図

【図５】　本発明実施例の光配線パッケージに用いる光電変換素子を示す構成図

【図６】　本発明実施例の光配線パッケージに用いる光電変換素子を示す構成図

【図７】　本発明実施例の光配線パッケージに用いる光電変換素子を示す構成図

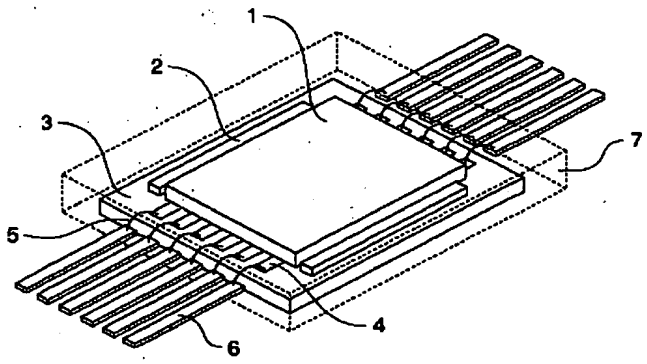
【図８】　本発明実施例の光配線パッケージの光端子部分を示す構成図

【図９】　本発明実施例の光配線パッケージに用いる光電変換素子を示す構成図

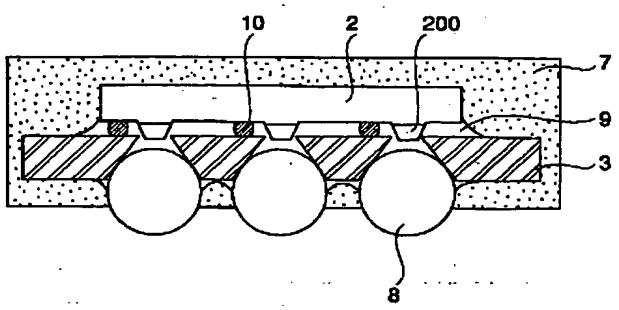
【符号の説明】

１　ＬＳＩチップ
２　光半導体素子（アレイ）
３　パッケージ基板
４　内部配線
５　ボンディングワイヤ
６　電気端子
７　モールド樹脂
８　球レンズ（光端子）
９　透明樹脂
１０　半田ボール
１１　光配線基板
１２　光導波路
１３　光入出力部（凹部）
１４　透明樹脂
１５　透明ロッド（光端子）
２００　光電変換素子能動部
２０１　半導体基板
２０２　下部ミラー
２０３　活性層
２０４　上部ミラー
２０５　モード制御領域（不要光吸収領域）
２０６　パッシベーション膜
２０７　配線電極
２０８　光吸収層
２０９　ウィンドウ層
２１０　不純物拡散領域
２１１　接地電極

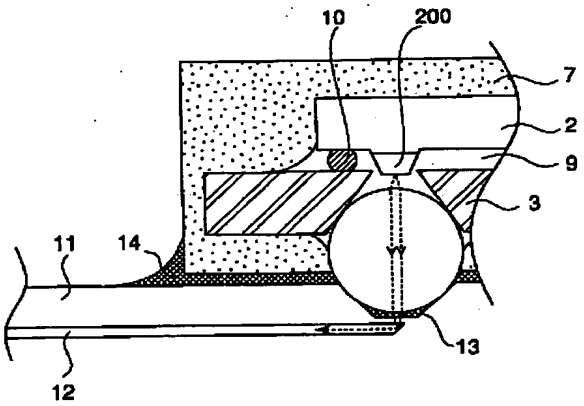
【図１】



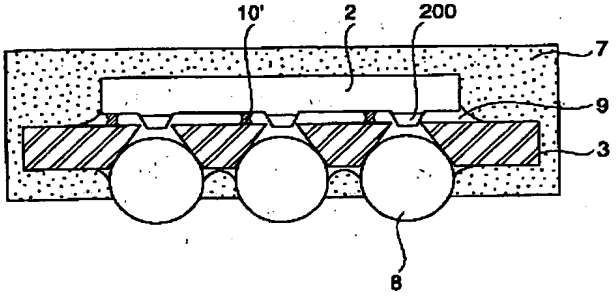
【図２】



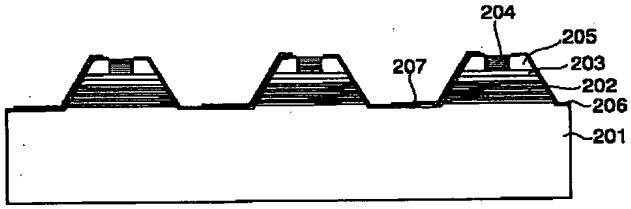
【図３】



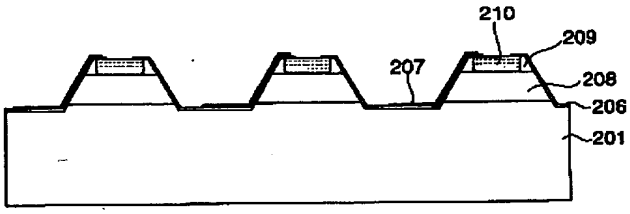
【図４】



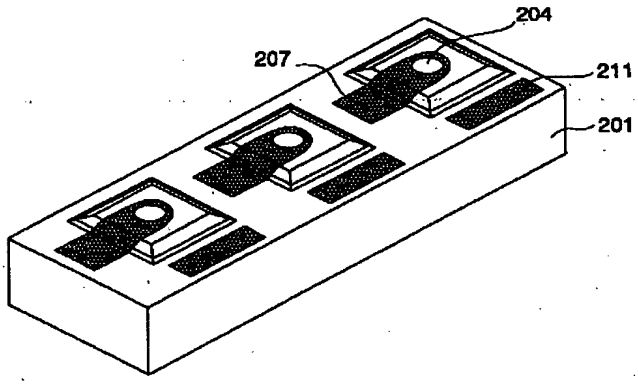
【図５】



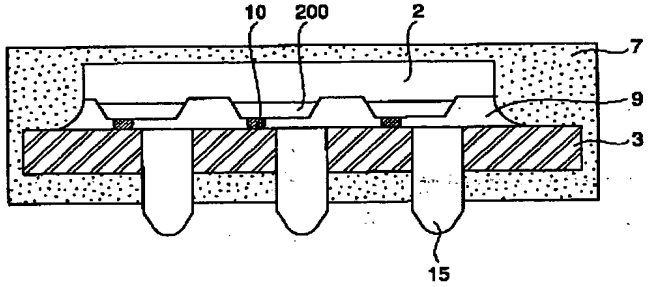
【図６】



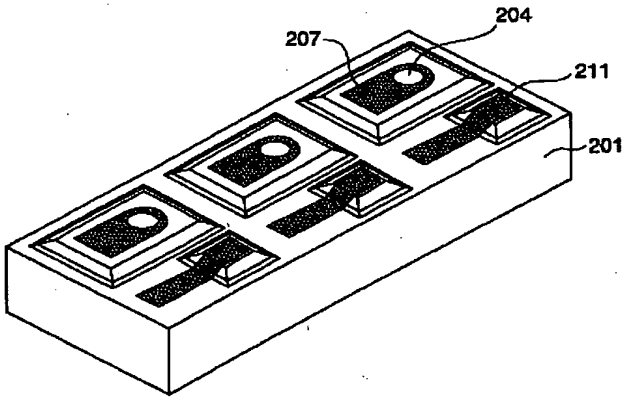
【図７】



【図８】



【図９】



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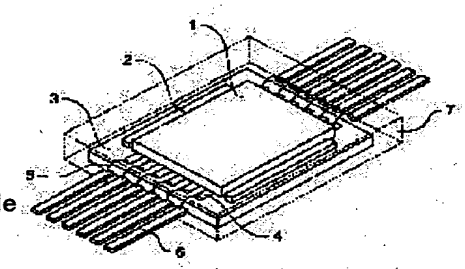
(54) OPTICAL WIRING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To inexpensively obtain a system operable at a high speed in a board level and rack level without raising mounting cost by inputting an optical signal into a photoelectric conversion element via an optical terminal and inputting a converted electric signal into an integrated circuit.

SOLUTION: An LSI chip 1, a photoelectric conversion element array 2, an internal wiring 4, a package substrate 3 and a bonding wire 5 are molded and packaged with one part of a electric terminal 6. The photoelectric conversion element array 2 is optically connected to an optical terminal via a through hole of the package substrate 3. Low speed signals such as control signals for the electric wiring and a operational mode of the LSI chip 1 are connected to the electric terminal 6 via the internal wiring 4 and the bonding wire 5. On the other hand, high speed signals such as a clock signal and data are connected to the photoelectric conversion element array 2 by the internal wiring or the bonding wire and are connected to an external part of the package substrate 3 as an optical signal. And the optical signal is inputted into a photoelectric conversion element via the optical terminal, is converted into an electric signal and is inputted into an integrated circuit.



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CLAIMS

[Claim(s)]
[Claim 1] A substrate, the integrated circuit arranged on this substrate, and the optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, It is arranged at the through tube prepared in said some of substrates, and this through tube, and said optoelectric transducer and the optical terminal which has the curved surface which counters are provided. The input to said integrated circuit Optical wiring equipment characterized by being carried out when a lightwave signal is inputted into said optoelectric transducer through said optical terminal, and said optoelectric transducer changes said lightwave signal into an electrical signal and inputs this electrical signal into said integrated circuit.
[Claim 2] A substrate, the integrated circuit arranged on this substrate, and the optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, It is arranged at the through tube prepared in said some of substrates, and this through tube, and said optoelectric transducer and the optical terminal which has the curved surface which counters are provided. The output from said integrated circuit Optical wiring equipment characterized by being carried out by outputting an electrical signal to said optoelectric transducer from said integrated circuit, and said optoelectric transducer's changing into a lightwave signal with this electrical signal, and outputting this lightwave signal through said optical terminal.
[Claim 3] The through tube prepared in said substrate is claim 1 characterized by having an inclination side face and said optical terminal being positioned by this inclination side face, or optical wiring equipment according to claim 2.
[Claim 4] A package substrate and the integrated circuit by which opposite arrangement was carried out on this package substrate, The optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, The through tube prepared in said some of package substrates, and the optical terminal which is arranged at this through tube and has said optoelectric transducer and the curved surface which counters, The optical wiring substrate by which opposite arrangement was carried out with said package substrate through said optical terminal is provided. The input to said integrated circuit Optical wiring equipment characterized by being carried out when a lightwave signal is inputted into said optoelectric transducer through said optical terminal, and said optoelectric transducer changes said lightwave signal into an electrical signal and inputs this electrical signal into said integrated circuit.
[Claim 5] A package substrate and the integrated circuit by which opposite arrangement was carried out on this package substrate, The optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, The through tube prepared in said some of package substrates, and the optical terminal which is arranged at this through tube and has said optoelectric transducer and the curved surface which counters, The optical wiring substrate by which opposite arrangement was carried out with said package substrate through said optical terminal is provided. The output from said integrated circuit Optical wiring equipment characterized by being carried out by outputting an electrical signal to said optoelectric transducer from said integrated circuit, and said optoelectric transducer's changing into a lightwave signal with this electrical signal, and outputting

this lightwave signal through said optical terminal.
[Claim 6] They are claim 4 characterized by being positioned so that the through tube prepared in said package substrate may have an inclination side face, the crevice in which said part of said optical wiring substrate by which optical coupling was carried out had an inclination side face may be prepared and said optical terminal, said optical waveguide, and said optoelectric transducer may carry out optical coupling according to these inclination side faces, or optical wiring equipment according to claim 5.
[Claim 7] Claim 4 or claim 5 light wiring equipment characterized by not exposing said optical waveguide on the front face of said optical wiring substrate by making the optical image formation location by said optical terminal into a location deeper than said crevice base, and locating said optical waveguide in this location.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical wiring equipment for carrying out high-speed mounting of the integrated circuit.
[0002]
[Description of the Prior Art] By improvement in the engine performance of electron devices, such as a bipolar transistor and a field-effect transistor, high-speed operation with fast LSI is becoming possible. However, although the interior action of LSI is accelerated, the working speed in the rack equipped with the printed circuit board level which mounted the LSI chip, or this printed circuit board is stopped lower than the working speed of LSI. Since the transmission loss and the noise of electric wiring, and electromagnetic interference will increase with a printed circuit board or a rack if clock frequency is raised, this reason is for the need that longer wiring lowers clock frequency to come out in order not to degrade especially a signal. Therefore, with electric wiring equipment, even if it raises the working speed of LSI which is an active element, there is a problem that a working speed cannot be improved because of the problem in a printed circuit board or a rack. On the other hand, in view of the problem of the above electric wiring equipments, some optical wiring equipments which connect between LSI with light are proposed. Since the description of wiring by light does not almost have frequency dependent [, such as loss,] from a direct current in a frequency domain dozens of GHz or more and there is neither electromagnetic interference of a wiring path nor a touch-down potential fluctuation noise, wiring which is dozens of Gbps is possible. In order to realize this optical wiring equipment, wiring which used optical waveguide is needed. Generally, connection of optical waveguide is made by comparison of a monotonous optical waveguide substrate or comparison of an optical fiber, it compares with the electric wiring approach, and there is little versatility. For this reason, optical wiring equipment is used only with

the special equipment restricted very much rather than compares and is common to electric wiring equipment.

[0003]

[Problem(s) to be Solved by the Invention] This invention solves the above-mentioned trouble and aims at offering the optical wiring line equipment for carrying out optical wiring mounting of the LSI general-purpose.

[0004]

[Means for Solving the Problem] The integrated circuit with which this invention has been arranged on a substrate and this substrate in order to attain the above-mentioned purpose, The optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, It is arranged at the through tube prepared in said some of substrates, and this through tube, and said optoelectric transducer and the optical terminal which has the curved surface which counters are provided. The input to said integrated circuit A lightwave signal is inputted into said optoelectric transducer through said optical terminal, said optoelectric transducer changes said lightwave signal into an electrical signal, and the optical wiring equipment characterized by being carried out by inputting this electrical signal into said integrated circuit is offered. Moreover, the optoelectric transducer which this invention is prepared on a substrate, the integrated circuit arranged on this substrate, and said substrate, and considers an exchange of an electrical signal as said integrated circuit, It is arranged at the through tube prepared in said some of substrates, and this through tube, and said optoelectric transducer and the optical terminal which has the curved surface which counters are provided. The output from said integrated circuit An electrical signal is outputted to said optoelectric transducer from said integrated circuit, said optoelectric transducer changes into a lightwave signal with this electrical signal, and the optical wiring equipment characterized by being carried out by outputting this lightwave signal through said optical terminal is offered.

[0005] Moreover, the through tube prepared in said substrate has an inclination side face, and the optical wiring equipment characterized by said optical terminal being positioned by this inclination side face is offered. Moreover, a package substrate and the integrated circuit by which opposite arrangement was carried out on this package substrate, The optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, The through tube prepared in said some of package substrates, and the optical terminal which is arranged at this through tube and has said optoelectric transducer and the curved surface which counters, The optical wiring substrate by which opposite arrangement was carried out with said package substrate through said optical terminal is provided. The input to said integrated circuit A lightwave signal is inputted into said optoelectric transducer through said optical terminal, said optoelectric transducer changes said lightwave signal into an electrical signal, and the optical wiring equipment characterized by being carried out by inputting this electrical signal into said integrated circuit is offered. Moreover, a package substrate and the integrated circuit by which opposite arrangement was carried out on this package substrate, The optoelectric transducer which is prepared on said substrate and considers an exchange of an electrical signal as said integrated circuit, The through tube prepared in said some of package substrates, and the optical terminal which is arranged at this through tube and has said optoelectric transducer and the curved surface which counters, The optical wiring substrate by which opposite arrangement was carried out with said package substrate through said optical terminal is provided. The output from said integrated circuit An electrical signal is outputted to said optoelectric transducer from said integrated circuit, said optoelectric transducer changes into a lightwave signal with this electrical signal, and the optical wiring equipment characterized by being carried out by outputting this lightwave signal through said optical terminal is offered.

[0006] Moreover, the through tube prepared in said package substrate has an inclination side face, the crevice in which said part of said optical wiring substrate by which optical coupling was carried out had an inclination side face is prepared, and the optical wiring equipment characterized by being positioned

so that said optical terminal, said optical waveguide, and said optoelectric transducer may carry out optical coupling according to these inclination side faces is offered. Moreover, the optical wiring equipment characterized by not exposing said optical waveguide on the front face of said optical wiring substrate is offered by making the optical image formation location by said optical terminal into a location deeper than said crevice base, and locating said optical waveguide in this location. The main point of this invention is that a semi-sphere or a tip performs [an OPTO semiconductor device and a tip] alignment of the optical axis of the optical input/output terminal of a ball taper configuration by the through tube which formed the package substrate which carries LSI and an OPTO semiconductor device in the interior of an integrated-circuit (LSI) package, and was prepared in the package substrate. Moreover, a crevice is established in the optical I/O section of an optical wiring substrate, while fixing said optical input/output terminal mechanically, alignment of a package substrate and the optical wiring substrate is carried out, and the focus of the lens of an optical input/output terminal is set to the optical waveguide in the interior of an optical wiring substrate. Moreover, the power source and low-speed signal terminal of an integrated circuit are electrically connected through an electrical connection pin, and a high speed signal is performed through an optoelectric transducer, an optical terminal, and optical waveguide. Thus, since a power source is given to the electronic device in an integrated circuit and a lightwave signal can perform a high speed signal, degradation of the signal in board level can be prevented.

[0007] According to this invention, since optical-axis adjustment of an optoelectric transducer and optical waveguide is divided into adjustment with an optoelectric transducer and an optical input/output terminal, and adjustment with an optical input/output terminal and optical waveguide, the same process separation as the usual LSI mounting, such as an LSI package and wiring substrate mounting, is possible. Therefore, production of an LSI package and a wiring substrate can be performed independently, and since there is no mounting of an optoelectric transducer in production of an optical wiring substrate, enlargement of an optical wiring substrate becomes easy. Moreover, an LSI package can be thrown into the LSI package process usual by the minimum process addition called optoelectric-transducer loading by using the package substrate which prepared the optical terminal beforehand. Furthermore, it is possible to carry out the checking and verifying of the optical terminal mechanically in the precision of alignment extent of an electric terminal in optical wiring substrate mounting, and since optical-axis doubling according to individual is unnecessary, mounting of others, an electronic device, etc. and coincidence is attained. Moreover, in order to locate the focal location of an optical terminal in the interior of an optical wiring substrate, a limit of the surface contamination of an optical wiring substrate is eased, and the handling becomes easy. Thus, if it depends on the optical wiring package and the optical wiring equipment of this invention, since the process of an optical wiring proper will be suppressed to the minimum and the technique of general electronic device mounting will become applicable, optical wiring mounting is attained without raising mounting cost sharply, and the effectiveness that the system in which high-speed operation is possible can be cheaply built on board level and rack level is done so.

[0008]

[Embodiment of the Invention] Hereafter, the detail of this invention is explained, referring to a drawing. Drawing 1 is the perspective view of the optical wiring package of this invention. On the package substrate 3, flip chip mounting of LSI chip 1 is carried out. The optoelectric-transducer array 2 is formed in the side of LSI chip 1, and a signal is electrically exchanged with an LSI chip. On the package substrate 3, the interior wiring 4 of the electrical and electric equipment is formed, and it connects with the electric terminal 6 by wire bonding 5. These electric wiring is connected with the power source of LSI, or the low-speed signal. With mold resin 7, the mold of some of LSI chip 1, the optoelectric-transducer array 2, internal wiring 4, package substrate 3 wire bonding 5, and electric terminals 6 is carried out, and it is package-ized. The optoelectric-transducer array 2 and an optical terminal are later mentioned about a concrete configuration, although optical coupling is carried out through the through

tube formed in the package substrate 3. Low-speed signals, such as power-source wiring of LSI chip 1 and a mode-of-operation control signal, are connected to an electric terminal 6 for such optical wiring equipment appearance through the internal wiring 4 and a bonding wire 5. On the other hand, the same bonding wire as the same internal wiring or 5 [same] connects with the optoelectric-transducer array 2, and the high speed signal of a clock signal, data, etc. is connected to the package substrate 3 exterior as a lightwave signal.

[0009] As an example of the making process of this package substrate 3, LSI chip 1 and the optoelectric-transducer array 2 are first carried in the package substrate 3 in which an optical terminal and internal wiring were formed. If flip chip mounting of LSI chip 1 and the optoelectric transducer 2 is carried out at this time, electrical connection of LSI chip 1, and the internal wiring 4 and the optoelectric-transducer array 2 of the package substrate 3 will be performed to coincidence. Or you may connect by wirebonding 5, respectively. Moreover, formation of an optical terminal and loading of LSI chip 1 or the optoelectric-transducer array 2 may be reverse orders. Next, wire connection (formation of a bonding wire 5) with a leadframe 6 is made, the mold of the whole is carried out with resin, such as an epoxy resin, cutting and plastic surgery of a lead (electric terminal 6) are performed, and a package is completed. At this time, the tip of an optical terminal processes metal mold so that it may expose to the exterior of mold resin, so that it may mention later. Drawing 2 R> 2 is the sectional view showing the example of a configuration of the optical wiring equipment of this invention shown by drawing 1 . It is arranged so that the optoelectric-transducer active section 200 of the optoelectric-transducer array 2 may counter, and the cap section is formed in the part in which the through tube which has the inclination side face of the package substrate 3 was formed with the solder ball for flip chip mounting.

[0010] The spherical lens (optical terminal) 8 is formed in this penetration posterior part so that it may fit in an inclination side face. The interior of a through tube and the gap section of the optoelectric-transducer array 2 and the package substrate 3 are filled up with transparence resin 9. 7 is said mold resin. After wiring for optoelectric-transducer 2 loading and the solder ball 10 are formed in the front face of the package substrate 3 and this optical wiring equipment carries the optoelectric-transducer array 2, the solder ball 10 is formed by performing solder melting by heat treatment. In order that the optoelectric-transducer array 2 may move to a predetermined location with the surface tension of the solder ball 10 at this time, the alignment of comparatively low precision of **10 micrometers is sufficient as loading of the early optoelectric-transducer array 2, and, finally precision of 1 micrometer or less is realized by the so-called flip chip bonding by solder tension. Moreover, Si substrate which has penetration opening formed with high precision by anisotropic etching may be used for the package substrate 3. The checking and verifying of the ball lens 8 can be carried out here, and the optical axis of the optoelectric-transducer array 2 and the ball lens 8 can be mechanically set with high precision by doubling with the above-mentioned flip chip bonding. Temporary immobilization of the ball lens 8 is carried out by transparence resin 9, and it performs final immobilization with the mold resin 7 of a package.

[0011] As a making process, first, the optoelectric-transducer array 2 is carried in the package substrate 3, for example, 300-degree C heat treatment is performed in an inert gas ambient atmosphere by using the solder ball 10 as an AuSn eutectic. Next, as transparence resin 9, in consideration of the stress concerning the optoelectric-transducer array 2, silicone system resin is poured in, and penetration opening of the package substrate 3 is continuously equipped with the ball lens 8. Next, after stiffening this transparence resin 9 by heat treatment, the resin mold of the whole is carried out. At this time, since it fills up with transparence resin 9 between the optoelectric-transducer array 2 and the ball lens beforehand, mold resin 7 does not advance into an optical path, and the optical property of mold resin 7 does not have to carry out special consideration, and may be used as resin with a high light absorption property also from the semantics which prevents invasion of the light from the external world conversely. Moreover, mold resin can use the package resin of the usual LSI, for example, should just

use the epoxy resin which added the glass filler and carried out coefficient-of-thermal-expansion adjustment. Of course, it sets up so that mold resin may not be covered with the metal mold at the time of carrying out mold at the tip of the optical terminal 8. Drawing 3 is the sectional view showing the optical wiring equipment of this invention, and carries the optical wiring equipment shown by drawing 2 on an optical wiring substrate. As shown in drawing 3 , for 11, as for optical waveguide and 13, an optical wiring substrate and 12 are [the optical terminal checking-and-verifying section for optical coupling (crevice) and 14] transparence resin, and the transparence resin of 14 serves as temporary immobilization of an optical wiring package, and the protection material of an optical path.

[0012] The so-called resin system optical waveguide substrates, such as the so-called textile-glass-yarn optical waveguide substrates, such as a quartz and multicomponent glass, and polymethylmethacrylate (PMMA), fluoridation polyimide, a polycarbonate (PC), can be used for the optical wiring substrate 11. In this example, optical waveguide is the thing of the gestalt which carries out optical propagation horizontally, and 45-degree processing of optical-path orthogonal transformation is performed in the optical waveguide edge (the optical I/O section, substrate crevice). In the case of the gestalt which what is depended on association and the internal mirror by the diffraction grating is available for this, and carries out optical propagation to a substrate perpendicular direction, especially the configuration of orthogonal transformation etc. is unnecessary. As an example of a mounting process of this example, first, transparence resin or the transparence resin adhesives 14 is applied to the optical I/O section 13 of the optical wiring substrate 11, and immobilization by loading of an optical wiring package and transparence resin 14 is performed. Transparence resin, such as silicone resin and an epoxy resin, should just be used for transparence resin 14. However, only by common transparence resin, although it becomes a bulking agent, in order to cause a location gap at a next process, adhesives may be used together to free space. Moreover, if the transparence adhesives of acrylic or an epoxy system are used, immobilization of an optical wiring package can also be performed to coincidence, and at this time, if ultraviolet-rays hardening resin etc. is used, it is fixable in a short time. This process is equivalent to the process of the temporary immobilization by positioning and adhesives which are used by mounting of a common LSI package, and is not necessarily an addition process of an optical wiring equipment proper.

[0013] Next, temporary immobilization of other packages, electronic devices, etc. is carried out, they cover the optical wiring substrate 11 over a solder reflow process, and make solder connection of an electric terminal. This process is the same as that of general LSI mounting. Thus, with the optical wiring equipment of this invention example, it can mount at a process almost equivalent to general LSI mounting, and the mounting approach usual only by modification of the resin ingredient with which an optical input/output terminal part is filled up can be applied. Moreover, since optical waveguide 12 is not exposed to the front face of the optical wiring substrate 11, even if it can treat the washing process of a wiring substrate etc. at the same process as the usual LSI mounting substrate and it has some penetrant remover remainders, since the focus of light is in the interior of a substrate, the effect is small. This is the effectiveness which optical disks, such as a compact disk, compare with a record etc., and is easy to deal with it, and the same effectiveness. Drawing 4 is other examples of the optical wiring package of this invention. The descriptions of this example are using usual connection solder 10' instead of 10 (solder bump) of drawing 2 , and inserting the optoelectric-transducer active section 200 in penetration opening of the package substrate 3, and applying and carrying out alignment of that appearance section to penetration opening mechanically. The advantage of this example is that formation of the passivation film for solder bump formation or the thick solder of dozens of micrometers becomes unnecessary, and since the reflow process for a solder bump becomes unnecessary, it is that reduction of the cost of materials and a conversion cost and compaction of process time amount are possible.

[0014] The example of the OPTO semiconductor device which has in the example of drawing 2 and drawing 3 , and is is shown in drawing 5 and drawing 6 . Drawing 5 is luminescence ********** (array)

and drawing 6 is a carrier optoelectric transducer (array), and perpendicular DBR (Distibuted Bragg Refrector) mold semiconductor laser is shown in drawing 5 , and it shows pin mold photograph DAODO (PIN-PD) to drawing 6 as an example of a carrier optoelectric transducer as an example of luminescence **********. 201 of drawing 5 — for a barrier layer and 204, as for a mode control section and 206, an up laminating mirror and 205 are [a semi-conductor substrate and 202 / a lower laminating mirror and 203 / surface passivation and 207] wiring electrodes (for the upper parts). As an example of oscillation wavelength, in the case of 0.78-micrometer band, GaAs and the laminating mirrors 202 and 204 use lambda/4 film of AlAs and AlGaAs, and, as for the thin film GaAs and the surface passivation film 206 as GaAlAs or the so-called quantum well, a barrier layer 203 should just use [the semi-conductor substrate 201] dielectric films, such as SiO2 film and SiNx film, etc. The mode control section 205 embeds GaAs, grows, and excepts the high order transverse mode and spurious radiation light. This effectiveness is for being making it the stray light of whenever [angle-of-elevation] not mix in the output light of an optical terminal, controlling the light which enters in addition to the original optical I/O section of an optical wiring substrate, and making it not produce evils, such as a cross talk.

[0015] For 201 of drawing 6 , as for a light absorption layer and 209, a semi-conductor substrate and 208 are [an up window layer and 210] impurity diffusion fields. According to the example of above-mentioned drawing 5 , in light-receiving of 0.78-micrometer band, GaAs of high carrier concentration and 208 set to GaAs of low carrier concentration, 209 sets to AlGaAs of high carrier concentration, and 201 introduces a **** type impurity contrary to the semi-conductor substrate 201 into 210 by thermal diffusion etc. If the seal of approval of the pn reverse bias is carried out to this component, the low carrier concentration layer of 208 will depletion-ize, and will produce the drift of the carrier by light absorption. Consequently, a high-speed response is attained and the high-speed response of several GHz or more is attained. In addition, when light-receiving wavelength is 0.78-micrometer band, Si can be used and an ingredient, then an equivalent function are altogether obtained in Si with the same carrier concentration structure. Drawing 5 , luminescence ********** of drawing 6 , and a carrier optoelectric transducer mesa—ization-processed the active section, as shown in drawing, and they have extended the electrode in the mesa lower part with the wiring electrode 207. Thereby, it can apply now also to the optical wiring package of mechanical alignment like drawing 4 R> 4. A perspective view shows this situation to drawing 7 . 211 of drawing 7 is an earth electrode and is formed in the location which shifted in the wiring electrode 207 of the component active section 204.

[0016] Although an earth electrode was not described especially in drawing 1 thru/or drawing 6 , although this may be put in block and may wire from the inferior surface of tongue of a substrate 201, it can be prepared according to an individual like drawing 7 , and can also be connected with the wiring electrode 207 on the package substrate 3 at coincidence. Since package wiring is pulled out in the direction perpendicular to the array array direction of an optoelectric transducer from 207 in that case, the earth electrode 211 has avoided and prepared the space. It is possible for this to reduce the stray capacity between an earth electrode and a signal electrode. In addition, light emitting diode is sufficient as luminescence ********** in the example of drawing 5 thru/or drawing 7 , and a metal semi-conductor contact mold component is sufficient as a carrier optoelectric transducer. Moreover, luminescence wavelength etc. can be changed with a design, an ingredient to be used of the optical wiring equipment to be used, and suitably, it can change and it can deform. Drawing 8 is other examples of the optical wiring package of this invention, and is the modifications of the optical wiring terminal of the example shown by drawing 2 and drawing 4 . Before the optical terminal 15 consists of glass or a transparence rod of resin and the description of this example carries an accumulation component and an optoelectric transducer 15 in the package substrate 3, it is to be able to form and set an optical terminal. For this reason, in the example of drawing 8 , after a package process is filled [of loading of an accumulation component and an optoelectric transducer, and transparence resin 9] up, it moves to a resin mold process immediately. Therefore, there is no wearing process of the lens according to the number of optical terminals, a process almost equivalent to a common LSI package can be applied, and

the process of an optical wiring package can be simplified sharply.
[0017] Although the optical terminal rod of a point ball taper is used in the example of drawing 8 , as for this, the object of a semi-sphere is sufficient as a tip. What is necessary is just to use proper use of a point ball taper and a semi-sphere properly by the design of optical association, and checking-and-verifying design with an optical wiring substrate. Drawing 9 is the example of the optoelectric transducer used for the example of drawing 8 , and a different point from drawing 7 is a point which the wiring electrode 207 is in a component front-face side, therefore also forms an earth electrode 211 on a dummy mesa, and is formed in a front-face side. In this case, since the tooth space of a dummy mesa is required, the drawer electrode of the wiring electrode 207 crosses by part for the substrate surface part of an earth electrode 211, but since it is spatially separated by the height of a mesa, stray capacity can also be comparatively made small. In addition, the optoelectric transducer of drawing 7 can be used also in the example of drawing 8 . Moreover, the optoelectric transducer of drawing 9 can be used for the example of drawing 2 and drawing 4 R> 4. These can respond by modification of the configuration of the package substrate 3 and an optoelectric transducer. Moreover, although the optoelectric-transducer array 2 and the semiconductor integrated circuit were mounted independently and it connected with electric wiring in the above-mentioned example, a semi-conductor optoelectric transducer may be integrated and used for a semiconductor integrated circuit.
[0018]
[Effect of the Invention] The effectiveness that the system in which high-speed operation is possible can be cheaply built on board level and rack level is done so, without according to this invention, attaining optical wiring by the mounting technique of a general electronic device, and raising mounting cost sharply, as stated above.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The outline block diagram of the optical wiring package of this invention example
[Drawing 2] The block diagram showing a part for the optical terminal area of the optical wiring package of this invention example
[Drawing 3] The block diagram showing the mounting condition of the optical wiring equipment of this invention example
[Drawing 4] The block diagram showing a part for the optical terminal area of the optical wiring package of this invention example
[Drawing 5] The block diagram showing the optoelectric transducer used for the optical wiring package of this invention example
[Drawing 6] The block diagram showing the optoelectric transducer used for the optical wiring package

of this invention example
[Drawing 7] The block diagram showing the optoelectric transducer used for the optical wiring package of this invention example
[Drawing 8] The block diagram showing a part for the optical terminal area of the optical wiring package of this invention example
[Drawing 9] The block diagram showing the optoelectric transducer used for the optical wiring package of this invention example
[Description of Notations]
1 LSI Chip
2 OPTO Semiconductor Device (Array)
3 Package Substrate
4 Internal Wiring
5 Bonding Wire
6 Electric Terminal
7 Mold Resin
8 Ball Lens (Optical Terminal)
9 Transparence Resin
10 Solder Ball
11 Optical Wiring Substrate
12 Optical Waveguide
13 Optical I/O Section (Crevice)
14 Transparence Resin
15 Transparence Rod (Optical Terminal)
200 Optoelectric-Transducer Active Section
201 Semi-conductor Substrate
202 Lower Mirror
203 Barrier Layer
204 Up Mirror
205 Mode Regulatory Region (Unnecessary Light Absorption Field)
206 Passivation Film
207 Wiring Electrode
208 Light Absorption Layer
209 Window Layer
210 Impurity Diffusion Field
211 Earth Electrode

[Translation done.]

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